

Tracts 1200
ON THE INFLUENCE OF
BRAIN-POWER ON HISTORY

AN ADDRESS

*Delivered before the British Association for the Advancement of
Science at Southport on September 9th, 1903*

BY

SIR NORMAN LOCKYER, K.C.B., LL.D., F.R.S.

CORRESPONDANT OF THE INSTITUTE OF FRANCE

PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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PREFACE

SEVERAL friends suggested that I should issue my Presidential address in pamphlet form. I thought it might be useful to do this if it could be accompanied by the data (which had been published in "Nature") on which a large part of the address is based. I therefore begged Messrs. Macmillan and the writers of the articles to grant me permission to reprint certain parts of them. This was at once given, and I have to express my best thanks for the favour thus extended to me.

NORMAN LOCKYER

16 *Penywern Road, S.W.*

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ON THE INFLUENCE OF BRAIN-POWER ON HISTORY

My first duty to-night is a sad one. I have to refer to a great loss which this nation and this Association have sustained. By the death of the great Englishman and great statesman who has just passed away we members of the British Association are deprived of one of the most illustrious of our past presidents. We have to mourn the loss of an enthusiastic student of science. We recognise that as Prime Minister he was mindful of the interests of science, and that to him we owe a more general recognition on the part of the State of the value to the nation of the work of scientific men. On all these grounds you will join in the expression of respectful sympathy with Lord Salisbury's family in their great personal loss which your Council has embodied this morning in a resolution of condolence.

Last year, when this friend of science ceased to be Prime Minister, he was succeeded by another statesman who also has given many proofs of his devotion to philosophical studies, and has shown in many utterances that he has a clear understanding of the real place of science in modern civilisation. We, then, have good grounds for hoping that the improvement in the position of science in this country which we owe to the one will also be the care of his successor, who has honoured the Association by accepting the unanimous nomination of your Council to be your President

next year, an acceptance which adds a new lustre to this Chair.

On this we may congratulate ourselves all the more because I think, although it is not generally recognised, that the century into which we have now well entered may be more momentous than any which has preceded it, and that the present history of the world is being so largely moulded by the influence of brain-power, which in these modern days has to do with natural as well as human forces and laws, that statesmen and politicians will have in the future to pay more regard to education and science as empire-builders and empire-guarders than they have paid in the past.

The nineteenth century will ever be known as the one in which the influences of science were first fully realised in civilised communities ; the scientific progress was so gigantic that it seems rash to predict that any of its successors can be more important in the life of any nation.

Disraeli, in 1873, referring to the progress up to that year, spoke as follows : "How much has happened in these fifty years—a period more remarkable than any, I will venture to say, in the annals of mankind. I am not thinking of the rise and fall of Empires, the change of dynasties, the establishment of Governments. I am thinking of those revolutions of science which have had much more effect than any political causes, which have changed the position and prospects of mankind more than all the conquests and all the codes and all the legislators that ever lived." ¹

The progress of science, indeed, brings in many considerations which are momentous in relation to the life of any limited community—any one nation. One of these considerations to which attention is now being greatly drawn is that a relative decline in national

¹ *Nature*, November 27, 1873, vol. ix., p. 71.

wealth derived from industries must follow a relative neglect of scientific education.

It was the late Prince Consort who first emphasised this when he came here fresh from the University of Bonn. Hence the "Prince Consort's Committee," which led to the foundation of the College of Chemistry, and afterwards of the Science and Art Department. From that time to this the warnings of our men of science have become louder and more urgent in each succeeding year. But this is not all ; the commercial output of one country in one century as compared with another is not alone in question ; the acquirement of the scientific spirit and a knowledge and utilisation of the forces of Nature are very much further reaching in their effects on the progress and decline of nations than is generally imagined.

Britain in the middle of the last century was certainly the country which gained most by the advent of science, for she was then in full possession of those material gifts of Nature, coal and iron, the combined winning and utilisation of which, in the production of machinery and in other ways, soon made her the richest country in the world, the seat and throne of invention and manufacture, as Mr. Carnegie has called her. Being the great producers and exporters of all kinds of manufactured goods, we became eventually, with our iron ships, the great carriers, and hence the supremacy of our mercantile marine and our present command of the sea.

The most fundamental change wrought by the early applications of science was in relation to producing and carrying power. With the winning of mineral wealth and the production of machinery in other countries, and cheap and rapid transit between nations, our superiority as depending upon our first use of vast material resources was reduced. Science, which is above

all things cosmopolitan—planetary, not national—internationalises such resources at once. In every market of the world

“things of beauty, things of use,
Which one fair planet can produce,
Brought from under every star,”

were soon to be found.

Hence the first great effect of the general progress of science was relatively to diminish the initial supremacy of Britain due to the first use of *material* resources, which indeed was the real source of our national wealth and place among the nations.

The unfortunate thing was that, while the foundations of our superiority depending upon our *material resources* were being thus sapped by a cause *which was beyond our control*, our statesmen and our Universities were blind leaders of the blind, and our other asset, our mental resources, which was within our control, was culpably neglected.

So little did the bulk of our statesmen know of the part science was playing in the modern world and of the real basis of the nation's activities that they imagined political and fiscal problems to be the only matters of importance. Nor, indeed, are we very much better off to-day. In the important discussions recently raised by Mr. Chamberlain next to nothing has been said of the effect of the progress of science on prices. The whole course of the modern world is attributed to the presence or absence of taxes on certain commodities in certain countries. The fact that the great fall in the price of food-stuffs in England did not come till some thirty or forty years after the removal of the corn duty between 1847 and 1849 gives them no pause; for them new inventions, railways, and steamships are negligible quantities; the vast increase in the world's wealth, in Free Trade and Protected countries alike,

comes merely, according to them, in response to some *political* shibboleth.

We now know, from what has occurred in other States, that if our Ministers had been more wise and our Universities more numerous and efficient our *mental resources* would have been developed by improvements in educational method, by the introduction of science into schools, and, more important than all the rest, by the teaching of science by experiment, observation, and research, and not from books. It is because this was not done that we have fallen behind other nations in properly applying science to industry, so that our applications of science to industry are relatively less important than they were. But this is by no means all ; we have lacked the strengthening of the national life produced by fostering the scientific spirit among all classes and along all lines of the nation's activity ; many of the responsible authorities know little and care less about science ; we have not learned that it is the duty of a State to organise its forces as carefully for peace as for war ; that Universities and other teaching centres are as important as battleships or big battalions ; are, in fact, essential parts of a modern State's machinery, and, as such, to be equally aided and as efficiently organised to secure its future well-being.

Now the objects of the British Association as laid down by its founders seventy-two years ago are "To give a stronger impulse and a more systematic direction to scientific inquiry—to promote the intercourse of those who cultivate science in different parts of the British Empire with one another and with foreign philosophers—to obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress."

In the main, my predecessors in this Chair, to which

you have done me the honour to call me, have dealt, and with great benefit to science, with the objects first named.

But at a critical time like the present I find it imperative to depart from the course so generally followed by my predecessors and to deal with the last object named, for unless by some means or other we "obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress," we shall suffer in competition with other communities in which science is more generally utilised for the purposes of the national life.

The Struggle for Existence in Modern Communities.

Some years ago, in discussing the relations of scientific instruction to our industries, Huxley pointed out that we were in presence of a new "struggle for existence," a struggle which, once commenced, must go on until only the fittest survives.

It is a struggle between organised species—nations—not between individuals or any class of individuals. It is, moreover, a struggle in which science and brains take the place of swords and sinews, on which depended the result of those conflicts which, up to the present, have determined the history and fate of nations. The school, the University, the laboratory, and the workshop are the battlefields of this new warfare.

But it is evident that if this, or anything like it, be true, our industries cannot be involved alone; the scientific spirit, brain-power, must not be limited to the workshop, if other nations utilise it in all branches of their administration and executive.

It is a question of an important change of front. It is a question of finding a new basis of stability for the

Empire in face of new conditions. I am certain that those familiar with the present state of things will acknowledge that the Prince of Wales's call, "Wake up," applies quite as much to the members of the Government as it does to the leaders of industry.

What is wanted is a complete organisation of the resources of the nation, so as to enable it best to face all the new problems which the progress of science, combined with the ebb and flow of population and other factors in international competition, are ever bringing before us. Every Minister, every public department, is involved ; and this being so, it is the duty of the whole nation—King, Lords, and Commons—to do what is necessary to place our scientific institutions on a proper footing in order to enable us to "face the music," whatever the future may bring. The idea that science is useful only to our industries comes from want of thought. If anyone is under the impression that Britain is only suffering at present from the want of the scientific spirit among our industrial classes, and that those employed in the State service possess adequate brain-power and grip of the conditions of the modern world into which science so largely enters, let him read the Report of the Royal Commission on the War in South Africa. There he will see how the whole "system" employed was, in Sir Henry Brackenbury's words applied to a part of it "*unsuited to the requirements of an army which is maintained to enable us to make war.*" Let him read also in the Address of the President of the Society of Chemical Industry what drastic steps had to be taken by Chambers of Commerce and "a quarter of a million of working-men" to get the Patent Law Amendment Act into proper shape in spite of all the advisers and officials of the Board of Trade. Very few people realise the immense number of scientific problems the solution of which is required for the State service.

The nation itself is a gigantic workshop ; and the more our rulers and legislators, administrators and executive officers possess the scientific spirit, the more the rule of thumb is replaced in the State service by scientific methods, the more able shall we be, thus armed at all points, to compete successfully with other countries along all lines of national as well as of commercial activity.

It is obvious that the power of a nation for war, in men and arms and ships, is one thing ; its power in the peace struggles to which I have referred is another. In the latter the source and standard of national efficiency are entirely changed. To meet war conditions, there must be equality or superiority in battleships and army corps. To meet the new peace conditions, there must be equality or superiority in Universities, scientific organisation, and everything which conduces to greater brain-power.

Our Industries are Suffering in the present International Competition.

The present condition of the nation, so far as its industries are concerned, is as well known, not only to the Prime Minister, but to other political leaders in and out of the cabinet, as it is to you and to me. Let me refer to two speeches delivered by Lord Rosebery and Mr. Chamberlain on two successive days in January 1901.

Lord Rosebery spoke as follows :—

“ . . . The war I regard with apprehension is the war of trade which is unmistakably upon us. . . . When I look round me I cannot blind my eyes to the fact that, so far as we can predict anything of the twentieth century on which we have now entered, it is that it will

be one of acutest international conflict in point of trade. We were the first nation of the modern world to discover that trade was an absolute necessity. For that we were nicknamed a nation of shopkeepers ; but now every nation wishes to be a nation of shopkeepers too, and I am bound to say that when we look at the character of some of these nations, and when we look at the intelligence of their preparations, we may well feel that it behoves us not to fear, but to gird up our loins in preparation for what is before us."

Mr. Chamberlain's views were stated in the following words :—

"I do not think it is necessary for me to say anything as to the urgency and necessity of scientific training. . . . It is not too much to say that the existence of this country, as the great commercial nation, depends upon it. . . . It depends very much upon what we are doing now, at the beginning of the twentieth century, whether at its end we shall continue to maintain our supremacy or even equality with our great commercial and manufacturing rivals."

All this refers to our industries. We are suffering because trade no longer follows the flag as in the old days, but because trade follows the brains, and our manufacturers are too apt to be careless in securing them. In one chemical establishment in Germany 400 doctors of science, the best the Universities there can turn out, have been employed at different times in late years. In the United States the most successful students in the higher teaching centres are snapped up the moment they have finished their course of training, and put into charge of large concerns, so that the idea has got abroad that youth is the password of success in American industry. It has been forgotten that the latest product of the highest scientific education must

necessarily be young, and that it is the training and not the age which determines his employment. In Britain, on the other hand, apprentices who can pay high premiums are too often preferred to those who are well educated, and the old rule-of-thumb processes are preferred to new developments—a conservatism too often depending upon the master's own want of knowledge.

I should not be doing my duty if I did not point out that the defeat of our industries one after another, concerning which both Lord Rosebery and Mr. Chamberlain express their anxiety, is by no means the only thing we have to consider. The matter is not one which concerns our industrial classes only, for knowledge must be pursued for its own sake; and since the full life of a nation with a constantly increasing complexity, not only of industrial, but of high national aims, depends upon the universal presence of the scientific spirit—in other words, brain-power—our whole national life is involved.

The Necessity for a Body dealing with the Organisation of Science.

The present awakening in relation to the nation's real needs is largely due to the warnings of men of science. But Mr. Balfour's terrible Manchester picture of our present educational condition ¹ shows that the warning, which has been going on now for more than fifty years, has not been forcible enough; but if my contention that other reorganisations besides that of our education are needed is well founded, and if men of science are to act the part of good citizens in taking their share in

¹ "The existing educational system of this country is chaotic, is ineffectual, is utterly behind the age, makes us the laughing-stock of every advanced nation in Europe and America, puts us behind, not only our American cousins, but the German and the Frenchman and the Italian."—*Times*, October 15, 1902.

endeavouring to bring about a better state of things, the question arises, Has the neglect of their warnings so far been due to the way in which these have been given?

Lord Rosebery, in the address to a Chamber of Commerce from which I have already quoted, expressed his opinion that such bodies do not exercise so much influence as might be expected of them. But if commercial men do not use all the power their organisation provides, do they not by having built up such an organisation put us students of science to shame, who are still the most disorganised members of the community?

Here, in my opinion, we have the real reason why the scientific needs of the nation fail to command the attention either of the public or of successive Governments. At present, appeals on this or on that behalf are the appeals of individuals; science has no collective voice on the larger national questions; there is no organised body which formulates her demands.

During many years it has been part of my duty to consider such matters, and I have been driven to the conclusion that our great crying need is to bring about an organisation of men of science, and all interested in science, similar to those which prove so effective in other branches of human activity. For the last few years I have dreamt of a Chamber, Guild, League, call it what you will, with a wide and large membership, which should give us what, in my opinion, is so urgently needed. Quite recently I sketched out such an organisation, but what was my astonishment to find that I had been forestalled, and by the founders of the British Association!

The British Association such a Body.

At the commencement of this Address I pointed out that one of the objects of the Association, as stated by its founders, was "to obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress."

Everyone connected with the British Association from its beginning may be congratulated upon the magnificent way in which the other objects of the Association have been carried out; but as one familiar with the Association for the last forty years I cannot but think that the object to which I have specially referred has been too much overshadowed by the work done in connection with the others.

A careful study of the early history of the Association leads me to the belief that the function I am now dwelling on was strongly in the minds of the founders; but be this as it may, let me point out how admirably the organisation is framed to enable men of science to influence public opinion, and so to bring pressure to bear upon Governments which follow public opinion. (1) Unlike all the other chief metropolitan societies, its outlook is not limited to any branch or branches of science. (2) We have a wide and numerous fellowship, including both the leaders and the lovers of science, in which all branches of science are and always have been included with the utmost catholicity—a condition which renders strong committees possible on any subject. (3) An annual meeting at a time when people can pay attention to the deliberations, and when the newspapers can print reports. (4) The possibility of beating up recruits and establishing local committees in different localities, even in the King's dominions beyond the seas,

since the place of meeting changes from year to year, and is not limited to these islands.

We not only, then, have a scientific Parliament competent to deal with all matters, including those of national importance, relating to science, but machinery for influencing all new councils and committees dealing with local matters, the functions of which are daily becoming more important.

The machinery might consist of our corresponding societies. We already have affiliated to us seventy societies with a membership of 25,000. Were this number increased so as to include every scientific society in the Empire, metropolitan and provincial, we might eventually hope for a membership of half a million.

I am glad to know that the Council is fully alive to the importance of giving a greater impetus to the work of the corresponding societies. During this year a committee was appointed to deal with the question; and later still, after this committee had reported, a conference was held between this committee and the corresponding societies committee to consider the suggestions made, some of which will be gathered from the following extract :—

“In view of the increasing importance of science to the nation at large, your committee desire to call the attention of the Council to the fact that in the corresponding societies the British Association has gathered in the various centres represented by these societies practically all the scientific activity of the provinces. The number of members and associates at present on the list of the corresponding societies approaches 25,000, and no organisation is in existence anywhere in the country better adapted than the British Association for stimulating, encouraging, and co-ordinating all the work being carried on by the seventy societies at present enrolled. Your committee are of

opinion that further encouragement should be given to these societies and their individual working members by every means within the power of the Association ; and with the object of keeping the corresponding societies in more permanent touch with the Association they suggest that an official invitation on behalf of the Council be addressed to the societies, through the corresponding societies committee, asking them to appoint standing British Association sub-committees, to be elected by themselves, with the object of dealing with all those subjects of investigation common to their societies and to the British Association committees, and to look after the general interests of science and scientific education throughout the provinces and provincial centres. . . .

“Your committee desire to lay special emphasis on the necessity for the extension of the scientific activity of the corresponding societies and the expert knowledge of many of their members in the direction of scientific education. They are of opinion that immense benefit would accrue to the country if the corresponding societies would keep this requirement especially in view with the object of securing adequate representation for scientific education on the Education Committees now being appointed under the new Act. The education section of the Association having been but recently added, the corresponding societies have as yet not had much opportunity for taking part in this branch of the Association’s work ; and in view of the reorganisation in education now going on all over the country your committee are of opinion that no more opportune time is likely to occur for the influence of scientific organisations to make itself felt as a real factor in national education. . . .”

I believe that if these suggestions or anything like

them—for some better way may be found on inquiry—are accepted, great good to science throughout the Empire will come. Rest assured that sooner or later such a Guild will be formed because it is needed. It is for you to say whether it shall be, or form part of, the British Association. We in this Empire certainly need to organise science as much as in Germany they find the need to organise a navy. The German Navy League, which has branches even in our Colonies, already has a membership of 630,000, and its income is nearly 20,000*l.* a year. A British Science League of 500,000 with a sixpenny subscription would give us 12,000*l.* a year, quite enough to begin with.

I for one believe that the British Association would be a vast gainer by such an expansion of one of its existing functions. Increased authority and prestige would follow its increased utility. The meetings would possess a new interest; there would be new subjects for reports; missionary work less needed than formerly would be replaced by efforts much more suited to the real wants of the time. This magnificent, strong, and complicated organisation would become a living force, working throughout the year instead of practically lying idle, useless, and rusting for fifty-one weeks out of the fifty-two so far as its close association with its members is concerned.

If this suggestion in any way commends itself to you, then when you begin your work in your sections or General Committee see to it that a body is appointed to inquire how the thing can be done. Remember that the British Association will be as much weakened by the creation of a new body to do the work I have shown to have been in the minds of its founders as I believe it will be strengthened by becoming completely effective in every one of the directions they indicated, and for which effectiveness we, their successors, are indeed

responsible. The time is appropriate for such a reinforcement of one of the wings of our organisation, for we have recently included Education among our sections.

There is another matter I should like to see referred to the committee I have spoken of, if it please you to appoint it. The British Association—which, as I have already pointed out, is now the chief body in the Empire which deals with the totality of science—is, I believe, the only organisation of any consequence which is without a charter, and which has not his Majesty the King as patron.

The First Work of such an Organisation.

I suppose it is my duty, after I have suggested the need of organisation, to tell you my personal opinion as to the matters where we suffer most in consequence of our lack of organisation at the present time.

Our position as a nation, our success as merchants, are in peril chiefly—dealing with preventable causes—because of our lack of completely efficient Universities and our neglect of research. This research has a double end. A professor who is not learning cannot teach properly or arouse enthusiasm in his students; while a student of anything who is unfamiliar with research methods, and without that training which research brings, will not be in the best position to apply his knowledge in after-life. From neglect of research comes imperfect education and a small output of new applications and new knowledge to reinvigorate our industries. From imperfect education comes the unconcern touching scientific matters and the too frequent absence of the scientific spirit in the nation generally, from the Court to the Parish Council.

I propose to deal as briefly as I can with each of these points.

Universities.

I have shown that, so far as our industries are concerned, the cause of our failure has been run to earth ; it is fully recognised that it arises from the insufficiency of our Universities both in numbers and efficiency, so that not only our captains of industry, but those employed in the nation's work generally, do not secure a training similar to that afforded by other nations. No additional endowment of primary, secondary, or technical instruction will mend matters. This is not merely the opinion of men of science ; our great towns know it, our Ministers know it.

It is sufficient for me to quote Mr. Chamberlain :—

“ It is not everyone who can, by any possibility, go forward into the higher spheres of education ; but it is from those who do that we have to look for the men who in the future will carry high the flag of this country in commercial, scientific, and economic competition with other nations. At the present moment I believe there is nothing more important than to supply the deficiencies which separate us from those with whom we are in the closest competition. In Germany, in America, in our own colony of Canada, and in Australia, the higher education of the people has more support from the Government, is carried further, than it is here in the Old Country ; and the result is that in every profession, in every industry, you find the places taken by men and by women who have had a University education. And I would like to see the time in this country when no man should have a chance for any occupation of the better kind, either in our factories, our workshops, or our counting-houses, who could not show proof that in the course of his University career

he had deserved the position that was offered to him. What is it that makes a country? Of course you may say, and you would be quite right, "The general qualities of the people, their resolution, their intelligence, their pertinacity, and many other good qualities." Yes; but that is not all, and it is not the main creative feature of a great nation. The greatness of a nation is made by its greatest men. It is those we want to educate. It is to those who are able to go, it may be, from the very lowest steps in the ladder, to men who are able to devote their time to higher education, that we have to look to continue the position which we now occupy as at all events one of the greatest nations on the face of the earth. And, feeling as I do on these subjects, you will not be surprised if I say that I think the time is coming when Governments will give more attention to this matter, and perhaps find a little more money to forward its interests."¹

Our conception of a University has changed. University education is no longer regarded as the luxury of the rich, which concerns only those who can afford to pay heavily for it. The Prime Minister in a recent speech, while properly pointing out that the collective effect of our public and secondary schools upon British character cannot be overrated, frankly acknowledged that the boys of seventeen or eighteen who have to be educated in them "do not care a farthing about the world they live in except in so far as it concerns the cricket-field or the football-field or the river." On this ground they are not to be taught science; and hence, when they proceed to the University, their curriculum is limited to subjects which were better taught before the modern world existed, or even Galileo was born. But the science which these young gentlemen neglect,

¹ *Times*, November 6, 1902.

with the full approval of their teachers, on their way through the school and the University to politics, the Civil Service, or the management of commercial concerns, is now one of the great necessities of a nation ; and our Universities must become as much the insurers of the future progress as battleships are the insurers of the present power of States. In other words, University competition between States is now as potent as competition in building battleships ; and it is on this ground that our University conditions become of the highest national concern, and therefore have to be referred to here, and all the more because our industries are not alone in question.

Why We have not More Universities.

Chief among the causes which have brought us to the terrible condition of inferiority as compared with other nations in which we find ourselves are our carelessness in the matter of education and our false notions of the limitations of State functions in relation to the conditions of modern civilisation.

Time was when the Navy was largely a matter of private and local effort. William the Conqueror gave privileges to the Cinque Ports on the condition that they furnished fifty-two ships when wanted. In the time of Edward III., of 730 sail engaged in the siege of Calais 705 were "people's ships." All this has passed away ; for our first line of defence we no longer depend on private and local effort.

Time was when not a penny was spent by the State on elementary education. Again, we no longer depend upon private and local effort. The Navy and primary education are now recognised as properly calling upon the public for the necessary financial support. But when we pass from primary to University education,

instead of State endowment we find State neglect ; we are in a region where it is nobody's business to see that anything is done.

We in Great Britain have thirteen Universities competing with 134 State and privately endowed in the United States and twenty-two State endowed in Germany. I leave other countries out of consideration for lack of time, and I omit all reference to higher institutions for technical training, of which Germany alone possesses nine of University rank, because they are less important ; they instruct rather than educate, and our want is education. The German State gives to one University more than the British Government allows to all the Universities and University Colleges in England, Ireland, Scotland, and Wales put together. These are the conditions which regulate the production of brain-power in the United States, Germany, and Britain respectively, and the excuse of the Government is that this is a matter for private effort. Do not our Ministers of State know that other civilised countries grant efficient State aid, and, further, that private effort has provided in Great Britain less than 10 per cent. of the sum thus furnished in the United States in addition to State aid ? Are they content that we should go under in the great struggle of the modern world because the Ministries of other States are wiser, and because the individual citizens of another country are more generous, than our own ?

If we grant that there was some excuse for the State's neglect so long as the higher teaching dealt only with words, and books alone had to be provided (for the streets of London and Paris have been used as classrooms at a pinch), it must not be forgotten that during the last hundred years not only has knowledge been enormously increased, but things have replaced words, and fully-equipped laboratories must take the

place of books and class-rooms if University training worthy of the name is to be provided. There is much more difference in size and kind between an old and new University than there is between the old caravel and a modern battleship, and the endowments must follow suit.

What are the facts relating to private endowment in this country? In spite of the munificence displayed by a small number of individuals in some localities, the truth must be spoken. In depending in our country upon this form of endowment we are trusting to a broken reed. If we take the twelve English University Colleges, the forerunners of Universities unless we are to perish from lack of knowledge, we find that private effort during sixty years has found less than 4,000,000*l.*; that is, 2,000,000*l.* for buildings, and 40,000*l.* a year income. This gives us an average of 166,000*l.* for buildings, and 3,300*l.* for yearly income.

What is the scale of private effort we have to compete with in regard to the American Universities?

In the United States, during the last few years, Universities and colleges have received more than 40,000,000*l.* from this source alone; private effort supplied nearly 7,000,000*l.* in the years 1898-1900.

Next consider the amount of State aid to Universities afforded in Germany. The buildings of the new University of Strassburg have already cost nearly a million; that is, about as much as has yet been found by private effort for buildings in Manchester, Liverpool, Birmingham, Bristol, Newcastle, and Sheffield. The Government annual endowment of the same German University is more than 49,000*l.*

This is what private endowment does for us in England, against State endowment in Germany.

But the State does really concede the principle; its

present contribution to our Universities and colleges amounts to 155,600*l.* a year. No capital sum, however, is taken for buildings. The State endowment of the University of Berlin in 1891-2 amounted to 168,777*l.*

When, then, we consider the large endowments of University education both in the United States and Germany, it is obvious that State aid only can make any valid competition possible with either. The more we study the facts, the more statistics are gone into, the more do we find that we, to a large extent, lack both of the sources of endowment upon one or other, or both, of which other nations depend. We are between two stools, and the prospect is hopeless without some drastic changes. And first among these, if we intend to get out of the present Slough of Despond, must be the giving up of the idea of relying upon private effort.

That we lose most where the State does least is known to Mr. Chamberlain, for in his speech, to which I have referred, on the University of Birmingham, he said: "As the importance of the aim we are pursuing becomes more and more impressed upon the minds of the people, we may find that we shall be more generously treated by the State."

Later still, on the occasion of a visit to University College School, Mr. Chamberlain spoke as follows:—

"When we are spending, as we are, many millions—I think it is 13,000,000*l.*—a year on primary education, it certainly seems as if we might add a little more, even a few tens of thousands, to what we give to University and secondary education."¹

To compete on equal grounds with other nations we must have more Universities. But this is not all

¹ *Times*, November 6, 1902.

—we want a far better endowment of all the existing ones, not forgetting better opportunities for research on the part of both professors and students. Another crying need is that of more professors and better pay. Another is the reduction of fees; they should be reduced to the level in those countries which are competing with us—to, say, one-fifth of their present rates, so as to enable more students in the secondary and technical schools to complete their education.

In all these ways facilities would be afforded for providing the highest instruction to a much greater number of students. At present there are almost as many *professors and instructors* in the Universities and colleges of the United States as there are *day students* in the Universities and colleges of the United Kingdom.

Men of science, our leaders of industry, and the chiefs of our political parties all agree that our present want of higher education—in other words, properly equipped Universities—is heavily handicapping us in the present race for commercial supremacy, because it provides a relatively inferior brain-power, which is leading to a relatively reduced national income.

The facts show that in this country we cannot depend upon private effort to put matters right. How about local effort?

Anyone who studies the statistics of modern municipalities will see that it is impossible for them to raise rates for the building and upkeep of Universities.

The buildings of the most modern University in Germany have cost a million. For upkeep the yearly sums found, chiefly by the State, for German Universities of different grades, taking the incomes of seven out of the twenty-two Universities as examples, are :—

First Class	Berlin	£ 130,000
Second Class. . . .	{ Bonn Göttingen }	. 56,000
Third Class	{ Königsberg Strassburg }	. 48,000
Fourth Class. . . .	{ Heidelberg Marburg }	. 37,000

Thus, if Leeds, which is to have a University, is content with the fourth class German standard, a rate must be levied of *7d.* in the pound for yearly expenses, independent of all buildings. But the facts are that our towns are already at the breaking strain. During the last fifty years, in spite of enormous increases in rateable values, the rates have gone up from about *2s.* to about *7s.* in the pound for real *local* purposes. But no University can be a merely local institution.

How to get More Universities.

What, then, is to be done? Fortunately, we have a precedent admirably in point, the consideration of which may help us to answer this question.

I have pointed out that in old days our Navy was chiefly provided by local and private effort. Fortunately for us those days have passed away; but some twenty years ago, in spite of a large expenditure, it began to be felt by those who knew, that in consequence of the increase of foreign navies our sea-power was threatened, as now, in consequence of the increase of foreign Universities, our brain-power is threatened.

The nation slowly woke up to find that its enormous commerce was no longer insured at sea, that in relation to foreign navies our own had been suffered to dwindle to such an extent that it was no longer capable of doing the duty which the nation expected of it even in times of peace. At first this revelation was received

with a shrug of incredulity, and the peace-at-any-price party denied that anything was needed; but a great teacher arose; ¹ as the facts were inquired into, the suspicion changed into an alarm; men of all parties saw that something must be done. Later the nation was thoroughly aroused, and with an universal agreement the principle was laid down that, cost what it might to enforce our sea-power, our Navy must be made and maintained of a strength greater than those of any two possibly contending Powers. After establishing this principle, the next thing to do was to give effect to it. What did the nation do after full discussion and inquiry? A Bill was brought in in 1888, and a sum of 21,500,000*l.* was voted in order, during the next five years, to inaugurate a large ship-building programme, so that Britain and Britain's commerce might be guarded on the high seas in any event.

Since then we have spent 120,000,000*l.* on new ships, and this year we spend still more millions on still more new ships. If these prove insufficient to safeguard our sea-power, there is no doubt that the nation will increase them, and I have not heard that anybody has suggested an appeal to private effort.

How, then, do we stand with regard to Universities, recognising them as the chief producers of brain-power and therefore the equivalents of battleships in relation to sea-power? Do their numbers come up to the standard established by the Admiralty principle to which I have referred? Let us attempt to get a rough-and-ready estimate of our educational position by counting Universities as the Admiralty counts battleships. I say rough-and-ready, because we have other helps to greater brain-power to consider besides

¹ Captain Mahan, of the U.S. Navy, whose book, "On the Influence of Sea-power on History," has suggested the title of my address.

Universities, as the Admiralty has other ships to consider besides ironclads.

In the first place, let us inquire if they are equal in number to those of any two nations commercially competing with us.

In the United Kingdom we had until quite recently thirteen.¹ Of these, one is only three years old as a teaching University, and another is still merely an examining board.

In Germany there are twenty-two Universities; in France, under recent legislation, fifteen; in Italy, twenty-one. It is difficult to give the number in the United States, because it is clear, from the tables given in the Report of the Commissioner of Education, that some colleges are more important than some Universities, and both give the degree of Ph.D. But of Universities in title we have 134. Among these, there are forty-six with more than fifty professors and instructors, and thirteen with more than 150. I will take that figure.

Suppose we consider the United States and Germany, our chief commercial competitors, and apply the Admiralty principle. We should require, allowing for population, eight additional Universities at the very lowest estimate.

We see, then, that instead of having Universities equalling in number those of two of our chief competitors together, they are by no means equal to those of either of them singly.

After this statement of the facts, anyone who has belief in the importance of higher education will have no difficulty in understanding the origin of the present condition of British industry and its constant decline,

¹ These are Oxford, Cambridge, Durham, Victoria, Wales, Birmingham, London, St. Andrews, Glasgow, Aberdeen, Edinburgh, Dublin, and Royal University.

first in one direction and then in another, since the tremendous efforts made in the United States and Germany began to take effect.

If, indeed, there be anything wrong about the comparison, the error can only arise from one of two sources—either the Admiralty is thoughtlessly and wastefully spending money, or there is no connection whatever between the higher intelligence and the prosperity of a nation. I have already referred to the views of Mr. Chamberlain and Lord Rosebery on this point ; we know what Mr. Chamberlain has done at Birmingham ; we know the strenuous efforts made by the commercial leaders of Manchester and Liverpool ; we know, also, the opinion of men of science.

If while we spend so freely to maintain our sea-power our export of manufactured articles is relatively reduced because our competitors beat us in the markets of the world, what is the end of the vista thus opened up to us ? A Navy growing stronger every year and requiring larger votes to guard our commerce and communications, and a vanishing quantity of commerce to guard—a reduced national income to meet an increasing taxation !

The pity is that our Government has considered sea-power alone ; that while so completely guarding our commerce it has given no thought to one of the main conditions on which its production and increase depend. A glance could have shown that other countries were building Universities even faster than they were building battleships ; were, in fact, considering brain-power first and sea-power afterwards.

Surely it is my duty as your President to point out the danger ahead, if such ignoring of the true situation should be allowed to continue. May I express a hope that at last, in Mr. Chamberlain's words, "the time is coming when Governments will give more attention to this matter" ?

What will they Cost?

The comparison shows that we want eight new Universities, some of which, of course, will be colleges promoted to University rank and fitted to carry on University work. Three of them are already named: Manchester, Liverpool, Leeds.

Let us take this number and deal with it on the battleship condition, although a modern University on American or German models will cost more to build than a battleship.

If our present University shortage be dealt with on battleship conditions, to correct it we should expend *at least* 8,000,000*l.* for new construction, and for the pay-sheet we should have to provide ($8 \times 50,000$ *l.*) 400,000*l.* yearly for *personnel* and up-keep; for it is of no use to build either ships or Universities without manning them. Let us say, roughly, capitalising the yearly payment at $2\frac{1}{2}$ per cent., 24,000,000*l.*

At this stage it is important to inquire whether this sum, arrived at by analogy merely, has any relation to our real University needs.

I have spent a year in making inquiries, as full as I could make them, of friends conversant with the real present needs of each of the Universities, old and new. I have obtained statistics which would fill a volume, and personally I believe that this sum at least is required to bring our University system up to anything like the level which is insisted upon both in the United States and in Germany. Even Oxford, our oldest University, will still continue to be a mere bundle of colleges unless three millions are provided to enable the University, properly so called, to take her place among her sisters of the modern world; and Sir Oliver Lodge, the Principal of our very youngest University, Birmingham,

has shown in detail how five millions can be usefully and properly applied in that one locality to utilise for the good of the nation the enthusiasm and scientific capacity which are only waiting for adequate opportunity of development.

How is this money to be raised? I reply, without hesitation, *Duplicate the Navy Bill of 1888-9*; do at once for brain-power what we so successfully did then for sea-power.

Let 24,000,000*l.* be set apart from one asset, our national wealth, to increase the other, brain-power. Let it be assigned and borrowed as it is wanted; there will be a capital sum for new buildings to be erected in the next five or ten years, the interest of the remainder to go towards increased annual endowments.

There need be no difficulty about allocating money to the various institutions. Let each University make up its mind as to which rank of the German Universities it wishes to emulate. When this claim has been agreed to, the sums necessary to provide the buildings and teaching staff of that class of University should be granted without demur.

It is the case of battleships over again, and money need not be spent more freely in one case than in the other.

Let me at once say that this sum is not to be regarded as practically gone when spent, as in the case of a short-lived ironclad. *It is a loan* which will bear a high rate of interest. This is not my opinion merely; it is the opinion of those concerned in great industrial enterprises and fully alive to the origin and effects of the present condition of things.

I have been careful to point out that the statement that our industries are suffering from our relative neglect of science does not rest on my authority. But if this be true, then if our annual production is less by

only two millions than it might have been, having two millions less to divide would be equivalent to our having forty or fifty millions less capital than we should have had if we had been more scientific.

Sir John Brunner, in a speech connected with the Liverpool School of Tropical Medicine, stated recently that if we as a nation were now to borrow ten millions of money in order to help science by putting up buildings and endowing professors, we should get the money back in the course of a generation a hundredfold. He added that there was no better investment for a business man than the encouragement of science, and that every penny he possessed had come from the application of science to commerce.

According to Sir Robert Giffen, the United Kingdom as a going concern was in 1901 worth 16,000,000,000*l.*

Were we to put aside 24,000,000*l.* for gradually organising, building, and endowing new Universities, and making the existing ones more efficient, we should still be worth 15,976,000,000*l.*—a property well worth defending by all the means, and chief among these brain-power, we can command.

If it be held that this, or anything like it, is too great a price to pay for correcting past carelessness or stupidity, the reply is that the 120,000,000*l.* recently spent on the Navy, a sum five times greater, has been spent to correct a sleepy blunder, not one whit more inimical to the future welfare of our country than that which has brought about our present educational position. We had not sufficiently recognised what other nations had done in the way of ship-building, just as until now we have not recognised what they have been doing in University building.

Further, I am told that the sum of 24,000,000*l.* is less than half the amount by which Germany is yearly enriched by having improved upon our chemical

industries, owing to our lack of scientific training. Many other industries have been attacked in the same way since ; but taking this one instance alone, if we had spent this money fifty years ago, when the Prince Consort first called attention to our backwardness, the nation would now be much richer than it is, and would have much less to fear from competition.

Suppose we were to set about putting our educational house in order, so as to secure a higher quality and greater quantity of brain-power, it would not be the first time in history that this has been done. Both Prussia after Jena and France after Sedan acted on the view :—

“ When land is gone and money spent,
Then learning is most excellent.”

After Jena, which left Prussia a “ bleeding and lacerated mass,” the King and his wise counsellors, among them men who had gained knowledge from Kant, determined, as they put it, “ to supply the loss of territory by intellectual effort.”

What did they do? In spite of universal poverty, three Universities, to say nothing of observatories and other institutions, were at once founded, secondary education was developed, and in a few years the mental resources were so well looked after that Lord Palmerston defined the kingdom in question as “ a country of damned professors.”

After Sedan—a battle, as Moltke told us, “ won by the schoolmaster ”—France made even more strenuous efforts. The old University of France, with its “ academies ” in various places, was replaced by fifteen independent Universities, in all of which are faculties of letters, sciences, law, and medicine.

The development of the University of Paris has been truly marvellous. In 1897–8 there were 12,000 students, and the cost was 200,000*l.* a year.

But even more wonderful than these examples is the "intellectual effort" made by Japan, not after a war, but to prepare for one.

The question is, Shall we wait for a disaster and then imitate Prussia and France ; or shall we follow Japan and thoroughly prepare by "intellectual effort" for the industrial struggle which lies before us ?

Such an effort seems to me to be the first thing any national or imperial scientific organisation should endeavour to bring about.

Research.

When dealing with our Universities I referred to the importance of research, as it is now generally acknowledged to be the most powerful engine of education that we possess. But education, after all, is but a means to the end, which, from the national point of view, is the application of old and the production of new knowledge.

Its national importance apart from education is now so generally recognised that in all civilised nations except our own means of research are being daily more amply provided for all students after they have passed through their University career ; and, more than this, for all who can increase the country's renown or prosperity by the making of new knowledge, upon which not only commercial progress, but all intellectual advance must depend.

I am so anxious that my statement of our pressing, and indeed imperative, needs in this direction should not be considered as resting upon the possibly interested opinion of a student of science merely that I must trouble you with still more quotations.

Listen to Mr. Balfour:—

“I do not believe that any man who looks round the equipment of our Universities or medical schools or other places of education can honestly say in his heart that we have done enough to equip research with all the costly armoury which research must have in these modern days. We, the richest country in the world, lag behind Germany, France, Switzerland, and Italy. Is it not disgraceful? Are we too poor or are we too stupid?”¹

It is imagined by many who have given no thought to the matter that this research should be closely allied with some application of science being utilised at the time. Nothing could be further from the truth; nothing could be more unwise than such a limitation.

Surely all the laws of Nature will be ultimately of service, and therefore there is much more future help to be got from a study of the unknown and the unused than we can hope to obtain by continuing the study of that which is pretty well known and utilised already. It was a King of France, Louis XIV., who first commended the study of the *même inutile*. The history of modern science shows us more and more as the years roll on the necessity and advantage of such studies, and therefore the importance of properly endowing them; for the production of new knowledge is a costly and unremunerative pursuit.

Years ago we had Faraday apparently wasting his energies and time in playing with needles; electricity now fills the world. To-day men of science in all lands are studying the emanations of radium; no research could be more abstract; but who knows what advance in human thought may follow or what gigantic world-transforming superstructure may

¹ *Nature*, May 30, 1901.

eventually be raised on the minute foundation they are laying?

If we so organise our teaching forces that we can use them at all stages, from the gutter to the University, to sift out for us potential Faradays—to utilise the mental products which otherwise would be wasted—it is only by enabling such men to continue their learning after their teaching is over that we shall be able to secure the greatest advantage which any educational system can afford.

It is now more than thirty years ago that my attention was specially drawn to this question of the endowment of research—first, by conversations with M. Dumas, the permanent secretary of the Academy of Sciences, who honoured me by his friendship; and, secondly, by my association with Sir Benjamin Brodie and Dr. Appleton in their endeavours to call attention to the matter in this country. At that time a general scheme of endowment suggested by Dumas was being carried out by Duruy. This took the form of the “*École spéciale des Hautes Études*”; it was what our fellowship system was meant to be—an endowment of the research of post-graduate students in each seat of learning. The French effort did not begin then.

I may here tell, as it was told me by Dumas, the story of Léon Foucault, whose many discoveries shed a glory on France and revived French industry in many directions.¹ In 1851, when Prince Napoleon was President of the Republic, he sent for Dumas and some of his colleagues, and told them that during his stay in England, and afterwards in his study of the Great Exhibition of that year, he had found there a greater industrial development than in France, and more applications of science, adding that he wished to know how such a state of things could be at once

¹ See *Proc. R. S.*, vol. xvii., p. lxxxiii.

remedied. The answer was that new applications depended upon new knowledge, and that therefore the most direct and immediate way was to find and encourage men who were likely by research in pure science to produce this new knowledge. The Prince-President at once asked for names; that of Léon Foucault was the only one mentioned during the first interview.

Some time afterwards—to be exact, at about eleven in the morning of December 2—Dumas's servant informed him that there was a gentleman in the hall named Foucault, who wished to see him, and he added that he appeared to be very ill. When shown into the study, Foucault was too agitated to speak, and was blind with tears. His reply to Dumas's soothing questions was to take from his pockets two rolls of banknotes, amounting to 200,000 francs, and place them on the table. Finally, he was able to say that he had been with the Prince-President since eight o'clock that morning, discussing the possible improvement of French science and industry; and that Napoleon had finally given him the money, requesting him to do all in his power to aid the State. Foucault ended by saying that, on realising the greatness of the task thus imposed upon him, his fears and feelings had got the better of him, for the responsibility seemed more than he could bear.¹

The movement in England to which I have referred began in 1872, when a society for the organisation of academical study was formed in connection with the

¹ In order to show how history is written, what actually happened on a fateful morning may be compared with the account given by Kinglake: 'Prince Louis rode home and went in out of sight. Then for the most part he remained close shut up in the Elysée. There, in an inner room, still decked in red trousers, but with his back to the daylight, they say he sat bent over a fireplace for hours and hours together, resting his elbows on his knees, and burying his face in his hands.'—*Crimean War*, vol. i., p. 245.

inquiry into the revenues of Oxford and Cambridge, and there was a famous meeting at the Freemasons' Tavern, Mark Pattison being in the chair. Brodie, Rolleston, Carpenter, Burdon-Sanderson, were among the speakers, and the first resolution carried was, "That to have a class of men whose lives are devoted to research is a national object." The movement died in consequence of the want of sympathy of the University authorities.¹

In the year 1874 the subject was inquired into by the late Duke of Devonshire's Commission; and after taking much remarkable evidence, including that of Lord Salisbury, the Commission recommended to the Government that the then grant of 1,000*l.*, which was expended, by a committee appointed by the Royal Society, on instruments needed in researches carried on by private individuals, should be increased, so that personal grants should be made. This recommendation was accepted and acted on; the grant was increased to 4,000*l.*, and finally other societies were associated with the Royal Society in its administration. The committee, however, was timorous, possibly owing to the apathy of the Universities and the general carelessness on such matters, and only one personal grant was made; the whole conception fell through.

Meantime, however, opinion has become more educated and alive to the extreme importance of research to the nation, and in 1891 a suggestion was made to the Royal Commission which administers the proceeds of the 1851 Exhibition that a sum of about 6,000*l.* a year available for scholarships should be employed in encouraging post-graduate research throughout the whole Empire. As what happened is told in the Memoirs of Lord Playfair, it is not indiscreet in me to state that when I proposed this new

¹ See *Nature*, November and December, 1872.

form of the endowment of research it would not have surprised me if the suggestion had been declined. It was carried through by Lord Playfair's enthusiastic support. This system has been at work ever since, and the good that has been done by it is now generally conceded.

It is a supreme satisfaction to me to know that in this present year of grace the national importance of the study of the *même inutile* is more generally recognised than it was during the times to which I have referred in my brief survey ; and, indeed, we students are fortunate in having on our side in this matter two members of His Majesty's Government, who two years ago spoke with no uncertain sound upon this matter :—

“Do we lack the imagination required to show what these apparently remote and abstract studies do for the happiness of mankind ? We can appreciate that which obviously and directly ministers to human advancement and felicity, but seem, somehow or another, to be deficient in that higher form of imagination, in that longer sight, which sees in studies which have no obvious, necessary, or immediate result the foundation of the knowledge which shall give far greater happiness to mankind than any immediate, material, industrial advancement can possibly do ; and I fear, and greatly fear, that, lacking that imagination, we have allowed ourselves to lag in the glorious race run now by civilised countries in pursuit of knowledge, and we have permitted ourselves so far to too large an extent to depend upon others for those additions to our knowledge which surely we might have made for ourselves.”¹

“I would remind you that all history shows that progress—national progress of every kind—depends

¹ Mr. Balfour, *Nature*, May 30, 1901.

upon certain individuals rather than upon the mass. Whether you take religion, or literature, or political government, or art, or commerce, the new ideas, the great steps, have been made by individuals of superior quality and genius, who have, as it were, dragged the mass of the nation up one step to a higher level. So it must be in regard to material progress. The position of the nation to-day is due to the efforts of men like Watt and Arkwright, or, in our own time, to the Armstrongs, the Whitworths, the Kelvins, and the Siemenses. These are the men who, by their discoveries, by their remarkable genius, have produced the ideas upon which others have acted and which have permeated the whole mass of the nation and affected the whole of its proceedings. Therefore what we have to do, and this is our special task and object, is to produce more of these great men.”¹

I finally come to the political importance of research. A country's research is as important in the long run as its battleships. The most eloquent teaching as to its national value we owe to Mr. Carnegie, for he has given the sum of 2,000,000/. to found a system of endowments, his chief purpose being, in his own words, “to secure if possible for the United States of America leadership in the domain of discovery and the utilisation of new forces for the benefit of man.”

Here is a distinct challenge to Britain. Judging by experience in this country, in spite of the magnificent endowment of research by Mond and Lord Iveagh, the only source of possible competition in the British interest is the State, which certainly could not put the 1/8000th part of the accumulated wealth of the country to better use ; for without such help both our Univer-

¹ Mr. Chamberlain, *Times*, January 18, 1901.

sities and our battleships will become of rapidly dwindling importance.

It is on this ground that I have included the importance of endowing research among the chief points to which I have been anxious to draw your attention.

The Need of a Scientific National Council.

In referring to the new struggle for existence among civilised communities I pointed out that the solution of a large number of scientific problems is now daily required for the State service, and that in this and other ways the source and standard of national efficiency have been greatly changed.

Much evidence bearing upon the amount of scientific knowledge required for the proper administration of the public departments, and the amount of scientific work done by and for the nation, was brought before the Royal Commission on Science presided over by the late Duke of Devonshire now more than a quarter of a century ago.

The Commission unanimously recommended that the State should be aided by a scientific council in facing the new problems constantly arising.

But while the home Government has apparently made up its mind to neglect the advice so seriously given, it should be a source of gratification to us all to know that the application of the resources of modern science to the economic, industrial, and agricultural development of India has for many years engaged the earnest attention of the Government of that country. The Famine Commissioners of 1878 laid much stress on the institution of scientific inquiry and experiment designed to lead to the gradual increase of the food-supply and to the greater stability of agricultural outturn, while the experience of recent years has indicated the

increasing importance of the study of the economic products and mineral-bearing tracts.

Lord Curzon has recently ordered the heads of the various scientific departments to form a board, which shall meet twice annually, to begin with, to formulate a programme and to review past work. The board is also to act as an advisory committee to the Government,¹ providing among other matters for the proper co-ordination of all matters of scientific inquiry affecting India's welfare.

Lord Curzon is to be warmly congratulated upon the step he has taken, which is certain to bring benefit to our great Dependency.

The importance of such a board is many times greater at home, with so many external as well as internal interests to look after—problems common to peace and war, problems requiring the help of the economic as well as of the physical sciences.

It may be asked, What is done in Germany, where science is fostered and utilised far more than here?

The answer is, There is such a council. I fancy, very much like what our Privy Council once was. It consists of representatives of the Ministry, the Universities, the industries, and agriculture. It is small, consisting of about a dozen members, consultative, and it reports direct to the Emperor. It does for industrial war what military and so-called defence councils do for national armaments; it considers everything relating to the use of brain-power in peace—from alterations in school regulations and the organisation of the Universities, to railway rates and fiscal schemes, including the adjustment of duties. I am informed that what this council advises, generally becomes law.

It should be pretty obvious that a nation so provided must have enormous chances in its favour. It is a

¹ *Nature*, September 4, 1902.

question of drilled battalions against an undisciplined army, of the use of the scientific spirit as opposed to the hope of "muddling through."

Mr. Haldane has recently reminded us that "the weapons which science places in the hands of those who engage in great rivalries of commerce leave those who are without them, however brave, as badly off as were the dervishes of Omdurman against the Maxims of Lord Kitchener."

Without such a machinery as this, how can our Ministers and our rulers be kept completely informed on a thousand things of vital importance? Why should our position and requirements as an industrial and thinking nation receive less attention from the authorities than the headdress of the Guards? How, in the words of Lord Curzon,¹ can "the life and vigour of a nation be summed up before the world in the person of its sovereign" if the national organisation is so defective that it has no means of keeping the head of the State informed on things touching the most vital and lasting interests of the country? We seem to be still in the Palæolithic Age in such matters, the chief difference being that the sword has replaced the flint implement.

Some may say that it is contrary to our habit to expect the Government to interest itself too much or to spend money on matters relating to peace; that war dangers are the only ones to be met or to be studied.

But this view leaves science and the progress of science out of the question. Every scientific advance is now, and will in the future be more and more, applied to war. It is no longer a question of an armed force with scientific corps; it is a question of an armed force scientific from top to bottom. Thank God, the Navy has already found this out. Science will ultimately rule

¹ *Times*, September 30, 1902.

all the operations both of peace and war, and therefore the industrial and the fighting population must both have a large common ground of education. Already it is not looking too far ahead to see that in a perfect State there will be a double use of each citizen—a peace use and a war use ; and the more science advances, the more the old difference between the peaceful citizen and the man at arms will disappear. The barrack, if it still exists, and the workshop will be assimilated ; the land unit, like the battleship, will become a school of applied science, self-contained, in which the officers will be the efficient teachers.

I do not think it is yet recognised how much the problem of national defence has thus become associated with that with which we are now chiefly concerned.

These, then, are some of the reasons which compel me to point out that a scientific council, which might be a scientific committee of the Privy Council, in dealing primarily with the national needs in times of peace, would be a source of strength to the nation.

To sum up, then. My earnest appeal to you is to gird up your loins and see to it that the science of the British Empire shall no longer remain unorganised. I have endeavoured to point out to you how the nation at present suffers from the absence of a powerful, continuous, reasoned expression of scientific opinion, urging in season and out of season that we shall be armed as other nations are, with efficient Universities and facilities for research to uphold the flag of Britain in the domain of learning and discovery, and what they alone can bring.

I have also endeavoured to show how, when this is done, the nation will still be less strong than it need be if there be not added to our many existing councils another, to secure that even during peace the benefits which a proper co-ordination of scientific effort in the nation's

interest can bring shall not be neglected as they are at present.

Lest some of you may think that the scientific organisation which I trust you will determine to found would risk success in working on such large lines, let me remind you that in 1859, when the late Prince Consort occupied this Chair, he referred to "impediments" to scientific progress, and said, "they are often such as can only be successfully dealt with by the powerful arm of the State or the long purse of the nation."

If the Prince Consort had lived to continue his advocacy of science, our position to-day would have been very different. His early death was as bad for Britain as the loss of a great campaign. If we cannot make up what we have lost, matters cannot mend.

I have done what I feel to be my duty in bringing the present condition of things before you. It is now your duty, if you agree with me, to see that it be put right. You can if you will.

APPENDICES

(1)

THE GERMAN UNIVERSITIES.¹

WHAT Germany thinks of the place of the University in a modern State can be readily gathered from the large and ever-increasing State endowments of the numerous Universities in Prussia and the other constituent countries.

The University activity of Prussia itself dates from the time after Jena, 1806, when the nation was, as Sir Rowland Blennerhassett has told us, a bleeding and lacerated mass, so impoverished and shattered that there seemed to be little future before it. King Frederick William III. and his councillors, among them Wilhelm von Humboldt, founded the University of Berlin, "to supply the loss of territory by intellectual effort." Among the universal poverty, money was also found for the Universities of Königsberg and Breslau, and Bonn was founded in 1818. Observatories and other scientific institutions were not forgotten. As a result of this policy, carried on persistently and continuously by successive Ministers, aided by wise councillors, many of them the products of this policy, such a state of things was brought about that Palmerston, a typical English statesman, is stated by Matthew Arnold to have defined the Germany of his day as a country of "damned professors," and so well have the damned professors done their work since that not long ago M. Ferdinand Lot, one of the most distinguished educationists of France, accorded to Germany "a supremacy in science comparable to the supremacy of England at sea."

The whole history of Prussia since then constitutes indeed a magnificent object lesson on the influence of brain-power on history. There can be no question that the Prussia of to-day,

¹ *Nature*, March 12, 1903.

the leader of a united Germany, with its armed strength both for peace and war and craving for a wider world dominion, is the direct outcome of the policy of "intellectual effort" inaugurated in 1806.

The most remarkable thing about the German universities in later years is the constant addition of new departments, added to enable them to meet and even to anticipate the demands made for laboratories in which each scientific subject, as it has been developed, can be taught on Liebig's plan, that is by experiment, observation and research.

It is in such State-aided institutions as these that the members of the German Ministry and Parliament, and the leading industrials are trained, while in our case, in consequence of the lack of funds for new buildings at Oxford and Cambridge, and, until not many years ago, the lack of other high-teaching centres, our leaders have had to be content with curricula extant before Galileo was born, the teaching being, perhaps, not so good and the desire to learn generally much less.

No one will deny that the brain-power of a nation must, in the last resort, depend upon the higher mental training obtainable in that nation. It is well, therefore, to see how we stand in this matter.

The following tables will show what the German Government is doing to provide brain-power in Germany. Those who know most about our British conditions will see how we are likely to fare in any competition with Germany in which brain-power comes in, if indeed there can be any important sphere of activity undertaken by either King, Lords or Commons in which brain-power does *not* come in.

We owe the first table giving the facts relating to the ordinary State endowments of the twenty-two German Universities to the kindness of Mr. Alexander Siemens, who was good enough to obtain through official sources an extract from the *Preussische Statistik* containing an article by Dr. Petersilie. This deals with 1891-2, the last year dealt with by the statistical bureau.

In the second table are given the *extraordinary* expenses incurred in the same year, also obtained from Dr. Petersilie's article. There have been added the State endowments for the years 1900-1 and 1902-3, so far as it has been possible to obtain them from *Minerva*, in order that the considerable yearly increase in the endowments may be noted.

It will be seen that those responsible for the continued well-

ON THE INFLUENCE OF

TABLE I.—*Ordinary State Endowment, Year 1891-2.*

Universities.	Ordinary Total In- come of Universities.	Sources of Income.				Expenditure.			
		Foundation Funds, Fees, &c.	State Funds.	Other Sources.	Percentage of		Salaries of Teaching Staff (in- cluding Lodging Allowance).	Various Personal Expenses.	Expenses Connected with Material.
					Founda- tion Funds.	State Funds.			
<i>a. Prussian Universities.</i>	£	£	£	£			£	£	£
1. Berlin	123,839	16,782	107,057	—	14	86	44,504	23,769	55,565
2. Bonn	56,467	10,661	45,806	—	19	81	24,404	8,334	23,729
3. Breslau	48,203	3,454	44,749	—	7	93	21,845	7,927	18,430
4. Göttingen	57,363	36,487	20,877	—	64	36	24,601	10,248	22,512
5. Greifswald	35,807	21,833	13,974	—	61	39	14,605	5,870	15,332
6. Halle	62,880	29,596	33,284	—	47	53	20,791	9,015	33,073
7. Kiel	37,722	9,584	28,188	—	25	75	13,471	5,682	18,618
8. Königsberg	46,405	6,475	39,930	—	14	86	17,193	7,374	21,836
9. Marburg	38,872	8,743	30,129	—	22	78	15,068	6,732	17,070
10. Munster Academy ...	12,312	4,202	8,110	—	34	66	8,000	1,737	2,574
11. Braunsberg Lyceum	2,040	1,046	994	—	51	49	1,741	82	216
Prussian Universities altogether	521,911	148,863	373,098	—	33	67	206,223	86,770	228,955

TABLE I.—Continued.

Universities.	Ordinary Total Income of Universities.	Sources of Income.				Percentage of		Expenditure.		
		Foundation Funds, Fees, &c.	State Funds.	Other Sources.	Foundation Funds.	State Funds.		Salaries of Teaching Staff (including Lodging Allowance).	Various Personal Expenses.	Expenses Connected with Material.
<i>b. Other than Prussian Universities.</i>	£	£	£	£				£	£	£
1. Munich ...	45,678	13,069	32,609	—	29	71		24,669	10,981	10,028
2. Wurzburg ...	36,246	15,707	20,539	—	43	57		14,999	11,316	10,831
3. Erlangen ...	31,722	6,813	24,909	—	21	79		11,591	10,149	9,982
4. Leipzig ...	99,373	21,439	77,934	—	22	78		27,162	43,917	28,293
5. Tübingen ...	44,068	5,309	38,759	—	12	88		13,669	12,602	17,798
6. Freiburg ...	25,984	3,996	21,893	95	16	84		13,021	3,538	9,424
7. Heidelberg ...	34,949	987	33,895	67	3	97		16,569	3,541	14,839
8. Giessen ...	32,749	9,530	23,178	41	29	71		11,988	2,358	18,402
9. Rostock ...	16,614	113	16,290	211	2	98		7,722	795	8,097
10. Jena ...	—	—	—	—	—	—		—	—	—
11. Strassburg ...	49,750	3,917	45,575	257	8	92		26,300	3,611	19,838
Non-Prussian universities altogether, excluding Jena ...	417,133	80,880	335,581	671	19	81		166,790	102,808	147,532
Prussian Universities All the German Universities, excluding Jena ...	521,911	148,863	373,098	—	33	67		206,223	86,770	228,955
	939,044	229,743	708,679	671	26	74		371,013	189,578	376,487

TABLE II.—*Showing Extraordinary Expenditure 1891-2, and Increase of Ordinary Endowment since then.*

Universities.	Ordinary State Endowment, 1891-2.	Extraordinary Expenditure Pro- vided by the State in 1891-2.	Ordinary State Endowment, 1900-1.	Ordinary State Endowment, 1902-3.	Increase of Ord- inary State Endow- ment in 11 years (in thousands).
<i>a. Prussian Universities.</i>					
1. Berlin	£ 107,057	£ 61,714	£ 130,743	£ 142,155	£ 35
2. Bonn	45,806	9,690	51,982	56,091	11
3. Breslau	44,749	38,900	57,435	57,435	13
4. Göttingen	20,877	6,260	27,403	30,414	10
5. Greifswald	13,974	5,762	20,490	23,925	10
6. Halle	33,284	15,919	51,666	54,419	21
7. Kiel	28,188	5,690	37,286	41,891	13
8. Königsberg	39,930	12,350	47,069	50,936	11
9. Marburg	30,129	2,660	36,255	38,931	8
10. Munster Academy	8,110	300	14,364	18,242	10
11. Braunsberg Lyceum	994	—	1,989	2,990	2
Prussian Universities; totals ...	373,098	159,245	476,682	517,429	144
<i>b. Other than Prussian Universities.</i>					
1. Munich	32,609	13,932	—	—	27
2. Wurzburg	20,539	375	—	—	14
3. Erlangen	24,909	3,766	—	—	9
4. Leipzig	77,934	—	101,989	104,388	8
5. Tübingen	38,759	—	49,703	52,234	19
6. Freiburg	21,893	7,825	28,555	30,955	9
7. Heidelberg	33,895	14,771	39,125	41,225	8
8. Giessen	23,178	6,990	37,480	42,188	19
9. Rostock	16,290	—	17,812	—	4
10. Jena	—	—	—	—	—
11. Strassburg	45,575	12,440	49,150	49,862	—
Non-Prussian Universities; totals...	335,581	60,099	323,814	320,852	—

being of the German State are as busily employed in increasing the efficiency of their Universities as they are in adding to their navy.

In Britain, there is no concern shown by our Government and politicians in regard to the *real* sources of *national* brain-power, towards which primary instruction, now well endowed, is but the first step. Private endowment is still appealed to, though our present unfortunate position comes from the fact that since the necessary introduction of science into the curriculum of the higher teaching, private endowment in the past has not been, nor in the future will it be, able to supply a tithe of what is really wanted.

(2)

THE UNIVERSITIES OF THE UNITED STATES.¹

Any consideration of what the nation has done for higher education in the United States must be prefaced by a reference to two laws passed in 1787 and 1862 respectively. The first Act, enacted for the Government of the territory north of the Ohio, provided that not more than two complete townships² were to be given to each State perpetually for the purposes of a "University to be applied to the intended object by the legislature of the State." In 1862 an Act was passed giving to each State thirty thousand acres of land for each senator and representative to which the State was then entitled, for the purpose of founding "at least one college, where the leading object shall be, without excluding other scientific and practical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States shall respectively prescribe, in order to promote the liberal education of the industrial classes in the several pursuits and professions of life."³

A reference to Table i. below, showing the number of acres of land in each of the States, the income accruing from which

¹ *Nature*, May 14, 1903.

² In surveys of the public land of the United States, a division of territory six miles square, containing thirty-six sections.

³ "Report of the Commissioner of Education for the Year 1896-7." Vol. ii. p. 1145. (Washington, 1898.)

is available for University education, demonstrates more conclusively than any words could do how very fully advantage has been taken throughout the United States of the legislative enactments of 1787 and 1862. The table is due to Dr. Frank W. Blackmar, and is contained in "The History of Federal

TABLE I.—*Land Grants and Reservations for Universities.*

States and Territories.	Acres.	Dates of Grant.
Ohio	69,120	1792, 1803
Indiana	46,080	1816, 1804
Illinois	46,080	1804, 1818
Missouri	46,080	1818, 1820
Alabama	46,080	1818, 1819
Mississippi	46,080	1803, 1819
Louisiana	46,080	1806, 1811, 1827
Michigan	46,080	1836
Arkansas	46,080	1836
Florida	92,160	1845
Iowa	46,080	1845
Wisconsin	92,160	1846, 1854
California	46,080	1853
Minnesota	82,640	1861, 1857, 1870
Oregon	46,080	1859, 1861
Kansas	46,080	1861
Nevada	46,080	1866
Nebraska	46,080	1864
Colorado	46,080	1875
Washington	46,080	1854, 1864
North Dakota }	46,080	1881
South Dakota }		
Montana	46,080	1881
Arizona Territory	46,080	1881
Idaho Territory	46,080	1881
Wyoming Territory	46,080	1881
New Mexico Territory	46,080	1854
Utah Territory	46,080	1855
Total	1,395,920	

and State Aid to Higher Education in the United States," published in Washington in 1890.

The grant of 1862 proved insufficient, and in 1890 an Act for the "more complete endowment of the institutions called into being or endowed by the Act of 1862" was passed.

But these land grants do not exhaust the means adopted by the State to encourage higher education in the United States.

In the book to which reference has been made, Dr. Blackmar summarises the principal ways in which the several States have aided higher education. They are as follows :—

- (1) By granting charters with privileges.
- (2) By freeing officers and students of colleges and Universities from military duties.
- (3) By exempting the persons and properties of the officers and students from taxation.
- (4) By granting land endowments.
- (5) By granting permanent money endowments by statute law.
- (6) By making special appropriations from funds raised by taxation.
- (7) By granting the benefits of lotteries.
- (8) By special gifts of buildings and sites.

The result is, as Prof. Edward Delavan Perry, of Columbia University, has said,¹ “At the present time, in each of the twenty-nine of the States of the Union, there is maintained a single ‘State University’ supported exclusively or prevailingly from public funds, and managed under the more or less direct control of the legislature and administrative officers of the State. These States are the following:—Alabama, California, Colorado, Georgia, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Michigan, Minnesota, Mississippi, Missouri, Nebraska, Nevada, North Carolina, North Dakota, Ohio, Oregon, South Carolina, South Dakota, Tennessee, Texas, Virginia, Washington, West Virginia, Wisconsin and Wyoming.

“The universal verdict of public opinion in the States where such institutions are maintained is that they, as State organisations supported directly by public taxation from which no taxable individual is exempt, should be open without distinction of sex, colour, or religion to all who can profit by the instruction therein given.”

The figures necessary to express how much University education in the United States owes to the American Government are large, and the total amount of the aid is enormous. The following table, drawn up with the assistance of the Report of the U.S. Commissioner of Education for the year 1899–1900, will enable the reader to form some idea of the splendid resources placed at the command of American

¹ See Prof. Nicholas Murray Butler’s monographs on “Education in the United States,” vol. i.

TABLE II.—*Statistics showing Value, Endowments, Appropriations, Income and Benefactions of Universities and Colleges in the United States in 1899-1900.*

State or Territory.	Value of Libraries, Apparatus, Grounds and Buildings.	Value of Endowments—Productive Funds.	Tuition and other Fees.	Income from Productive Funds.	State, Municipal and U.S. Government Appropriations.	Income from other Sources.	Total Income.	Benefactions.
	£	£	£	£	£	£	£	£
Maine	351,200	377,900	17,600	17,500	14,000	3,000	52,100	13,900
New Hampshire	220,600	460,000	8,900	12,000	2,000	0	22,900	70,000
Vermont	198,700	165,000	3,600	9,100	8,100	1,500	22,300	28,700
Massachusetts	3,084,800	4,083,000	292,500	179,300	0	50,000	521,800	257,600
Rhode Island	301,700	259,400	19,400	15,700	0	300	35,400	30,400
Connecticut	1,577,800	1,414,300	106,900	69,700	0	5,700	182,300	156,400
New York	5,846,400	5,681,500	289,000	257,400	48,300	111,000	705,700	363,300
New Jersey	983,300	563,300	39,600	26,700	8,000	0	74,300	47,200
Pennsylvania	3,075,600	2,381,800	217,000	95,000	43,500	34,600	390,100	170,500
Delaware	34,000	16,600	300	1,000	8,000	600	9,900	—
Maryland	784,000	754,400	54,800	19,700	19,000	11,600	105,100	13,000
Columbia	974,900	279,400	34,300	14,700	20,600	14,700	14,300	14,600
Virginia	753,000	392,600	48,200	20,500	12,800	9,400	90,900	16,400
West Virginia	119,700	33,900	4,100	1,800	28,700	3,600	38,200	10,200
North Carolina	484,500	179,000	38,100	10,101	5,000	11,500	64,700	17,700
South Carolina	303,400	123,800	23,700	6,800	5,900	7,800	44,200	30,400
Georgia	491,600	184,400	37,900	11,400	5,400	8,600	63,300	20,700
Florida	104,800	85,100	4,500	5,400	4,500	0	14,400	3,500
Kentucky	437,100	332,400	33,700	17,000	13,400	9,800	73,900	27,500
Tennessee	992,000	527,000	70,200	26,900	12,700	33,700	143,500	58,800
Alabama	325,800	70,000	20,300	2,400	2,500	6,000	31,200	2,100
Mississippi	233,000	180,300	23,800	8,300	12,900	8,000	53,000	200
Louisiana	436,300	387,900	18,800	25,000	8,600	1,700	54,100	3,000
Texas	444,600	143,900	46,000	7,600	15,600	21,000	90,200	20,100
Arkansas	133,300	33,000	10,000	2,400	13,300	1,600	27,300	3,900

TABLE II.—Continued.

State or Territory.	Value of Libraries, Apparatus, Grounds and Buildings.	Value of Endowments— Productive Funds.	Tuition and other Fees.	Income from Productive Funds.	State, Muni- cipal and U.S. Govern- ment Appro- priations.	Income from other Sources.	Total Income.	Benefactions.
Oklahoma...	£ 14,600	£ —	£ 200	£ 0	£ 3,800	£ 0	£ 4,000	£ —
Indian Territory	13,500	200	1,200	0	0	1,000	2,200	1,800
Ohio ..	2,114,900	1,901,500	91,200	84,700	64,400	26,300	266,600	133,600
Indiana ..	867,200	431,100	30,900	23,000	17,500	5,200	76,600	12,300
Illinois ..	2,256,000	2,310,500	199,400	96,800	61,500	31,100	388,800	386,900
Michigan ..	678,800	374,600	50,000	19,300	58,700	10,600	138,600	56,800
Wisconsin...	627,300	334,000	22,800	15,300	62,800	4,500	105,400	10,400
Minnesota...	627,100	332,700	35,200	15,400	35,100	8,900	94,600	15,200
Iowa ...	632,500	300,800	48,400	18,900	15,000	31,600	113,900	51,600
Missouri ..	1,359,800	737,300	77,200	33,800	14,900	19,600	145,500	67,400
North Dakota ..	47,700	8,000	1,000	600	9,100	0	10,700	4,800
South Dakota ..	92,400	20,000	4,600	800	6,600	1,100	13,100	19,200
Nebraska ..	451,300	67,300	13,700	3,800	46,400	4,400	68,300	9,400
Kansas ..	624,900	84,000	33,900	5,300	24,000	18,500	81,700	23,500
Montana ..	43,700	—	1,900	2,000	4,300	0	8,200	—
Wyoming ...	43,300	1,400	100	0	1,000	100	11,200	0
Colorado ...	343,300	124,000	8,000	7,400	14,400	2,200	32,000	46,600
New Mexico ..	16,500	—	100	0	2,200	0	2,300	2,700
Arizona ..	30,900	—	—	0	10,000	500	10,500	—
Utah ...	126,900	51,400	2,900	1,300	12,300	2,900	19,400	800
Nevada ..	50,400	—	—	—	11,400	0	11,400	—
Idaho ..	49,900	—	0	0	10,000	0	10,000	0
Washington ..	269,600	37,700	11,000	2,500	10,000	500	24,000	45,500
Oregon ...	124,900	89,000	5,200	4,400	6,000	900	16,500	5,600
California ...	1,376,000	4,250,200	41,100	78,500	55,300	3,500	178,400	11,300

Universities. The grand totals under each heading will be found in Tables v. and vi., so arranged as to show the proportion of each total available for the University education of women.

The Universities and colleges of the United States have another source of income in addition to the generous provision made by the State. Every year wealthy American citizens place large sums of money at the disposal of the educational authorities for the purposes of higher education and the encouragement of scientific research. During the eleven years 1890-1901, the amount of these donations reached the grand total of nearly 23,000,000*l.*, as Table iii., compiled by Prof. Nicholas Murray Butler, shows :—

TABLE III.—*Total amount of Benefactions¹ to Higher Education in the United States.*

Reported in		£	Reported in		£
1890-91	...	1,515,018	1896-97	...	1,678,187
1891-92	...	1,336,917	1897-98	...	1,640,856
1892-93	...	1,343,027	1898-99	...	4,385,087
1893-94	...	1,890,101	1899-1900	...	2,399,092
1894-95	...	1,199,645	1900-01	...	3,608,082
1895-96	...	1,810,021			

From 1871-1890, the total amount of benefactions for education of the kind with which this article is concerned was, the annual reports of the U.S. Bureau of Education show, 16,285,000*l.*, so that for the years 1871-1901, the grand total of forty millions sterling was raised by private effort for American University education.

The question naturally presents itself, What has been done by private effort in this country to assist University education during the same period? Compared with American munificence, the amounts given and bequeathed here are very small. Take in the first place the University Colleges, which are largely to be regarded as a growth of the years under consideration. The financial statements contained in the "Reports from University Colleges, 1901," published by the Board of Education, reveal the fact that, including the 400,000*l.* raised for the University of Birmingham, the benefactions to the fifteen University Colleges in Great Britain amounted during 1870-1900

¹ Compiled by Prof. Nicholas Murray Butler, Columbia University, and published in "Special Reports on Educational Subjects," vol. xi. part ii.

to a little more than three millions. In the absence of systematic reports during the same period of the financial resources of the older Universities of the United Kingdom, it is difficult to estimate the amount of benefactions received by them during the same thirty years. The parliamentary returns which have been published since 1898, showing the revenue of Scottish Universities, suggest that their benefactions in the same time, excluding Mr. Carnegie's splendid gift, may be put at something under half a million, so that for the whole of the United Kingdom the total amount of endowment from private sources

TABLE IV.—*Classification of Colleges and Universities for Men and for both Sexes, according to Amount of Endowment Fund.*

£		£				
20,000	to	40,000	...	...	...	56
40,000	"	60,000	..	...	...	38
60,000	"	80,000	...	...	...	13
80,000	"	100,000	...	...	...	14
100,000	"	120,000	...	...	...	7
120,000	"	140,000	...	...	...	4
140,000	"	160,000	...	...	...	5
160,000	"	180,000	...	...	...	2
180,000	"	200,000	...	...	...	1
200,000	"	250,000	...	...	...	8
250,000	"	300,000	...	...	...	5
300,000	"	400,000	...	...	...	3
400,000	"	600,000	...	...	...	4
600,000	"	800,000	...	...	...	4
800,000	"	1,000,000	...	...	...	1
1,000,000	"	1,500,000	...	...	...	2
1,500,000	"	2,000,000	...	...	...	—
		Over 2,000,000	...	...	...	3

raised in these years may, without any risk of under-estimation, be said to be considerably less than five millions.

To give some idea of the result of the broad-minded policy of the legislatures of the several States and of the treatment which higher education has received at the hands of American statesmen and men of wealth, the following short summaries have been drawn up, with the assistance of the Report of the Commissioner of Education of the United States Bureau at Washington, published in 1901, for the year 1899-1900. The first (Table iv.) shows the number of colleges having endowments of certain specified amounts. The second summary (Table v.) shows the total property of all American University Colleges, tabulated under the headings of fellowships and

TABLE V.—*Property of Universities and Colleges in the United States (1899-1900).*

Description of institution.	Number of fellowships.	Number of scholarships.	Value of libraries.	Value of scientific apparatus.	Value of grounds and buildings.	Productive funds.
For men and for both sexes ...	476	7,619	£ 2,138,000	£ 3,027,000	£ 27,267,000	£ 29,478,000
For women ...	18	447	132,000	157,000	3,129,000	1,088,000

TABLE VI.—*Income of Universities and Colleges in the United States (1899-1900).*

Description of institution.	Fees.	From productive funds.	State or municipal appropriations.	From United States Government.	From other sources.	Total income.	Benefactions.
For men and for both sexes ...	£ 1,675,000	£ 1,222,000	£ 691,900	£ 197,000	£ 393,000	£ 4,179,000	£ 2,168,000
For women ...	468,000	57,000	7,000	—	136,000	670,000	118,000

scholarships ; values of libraries, apparatus, grounds and buildings ; and of their productive funds. The next (Table vi.) shows the amounts of income of these colleges, and the last (Table vii.) gives the total number of professors, instructors and students in colleges of University standing.

It is interesting in this connection to compare the number of students taking University courses in this country with those in Germany and the United States. With this object in view, Table viii. has been prepared, but it should be pointed out that the number of students in our University Colleges includes all above the age of sixteen, which is probably much lower than

TABLE VII.—*Professors, Instructors and Students in Universities and Colleges of United States.*

Institutions.	Professors and Instructors. ¹	
	Men.	Women.
For men and for both sexes (480 institutions)	12,664	1,816
For women (141 institutions) ...	697	1,744
	Students.	
	Men.	Women.
Total number of students in Universities and colleges... ..	61,800	35,300

the age of these students included in the totals for other countries. It is well to remember, too, that the number of American University students is probably too high for a fair comparison with those of Germany. Many University students in the United States are really students in the higher branches of technology, and would in Germany study in technical high schools, the students of which are not included in Germany's total in the table. To make the comparisons as simple as possible the number of University students per ten thousand of population has been calculated.

The statistics provided above make it possible to form a good estimate of the comparative amounts of importance attached to

¹ Excluding duplicates.

higher education in this country and in the United States. Table vi. shows that, neglecting the income accruing from the State land grants, the legislatures of individual States and the U.S. Government together supplied about 900,000*l.* for University education during 1899-1900, while the article in *NATURE* for March 12, 1903, shows that the total State aid to Universities and colleges in the United Kingdom at present amounts only to 155,600*l.* Table vi. also brings out another important principle ; it reveals the fact that during 1899-1900

TABLE VIII.—*Number of University Students per 10,000 of Population (1900).*

Country.	Population.	Number of Students.			Number of Students per 10,000 of Population.
		Universities University Colleges }	Day. 12,000 8,500	Evening 5,000	
United Kingdom	41,164,000				4·98 ¹
German Empire	56,367,000		44,400		7·87
United States	76,086,000		97,100		12·76

private effort provided more than two and a quarter millions sterling for the colleges of the United States, and thus leads to the conclusion, which is strengthened by Table iii., that interest on the part of the State in higher education leads to a corresponding enthusiasm among men of wealth.

A comparative study of this kind is of vital national interest ; our very existence as a nation depends directly upon success in that industrial warfare between the great countries of the world from which there can be no peace. The last article in this series has shown the great importance attached by German statesmen to the higher education of the directors of German industries, and how greatly superior is the provision made for this purpose in Germany to that in this country. A similar conclusion is reached by studying the subject from the American point of view ; we are equally behind the United States. Unless our Government, on one hand, and our men of

¹ Excluding evening students of University Colleges.

wealth on the other, take immediate steps, and make serious efforts to remedy these deficiencies in our higher education, British manufacturers cannot hope to hold their own successfully with either German or American competitors. The amount by which we fall short of the United States, the deficiency which must be made good simply to bring us level with America in the race for industrial supremacy, will be seen from the following deductions from the above statistics :—

(1) The amount raised during 1871–1901 by private munificence for higher education was, in the United States, more than eight times that similarly provided in the United Kingdom.

(2) In addition to the large income from State land grants, the amount provided by the State for higher education is, in the United States, six times as much as the Government grant for the same purpose in the United Kingdom, where there is nothing corresponding to the land grants.

(3) In the United States there are 170 colleges with an endowment of more than 20,000*l.*; forty-nine of these have endowments of more than 100,000*l.*, and three of more than two millions sterling. In the United Kingdom there are thirteen Universities and twenty other University Colleges. Four of the Universities do little more than examine.

(4) In the United States nearly thirteen of every ten thousand inhabitants are studying during the day at colleges of University status; the number in the United Kingdom is less than five.

(5) The value of the endowments of institutions of higher education in the single State of New York exceeds the total amount of benefactions for similar purposes raised during thirty years in the whole of the United Kingdom. The same is nearly true in the States of Massachusetts and of California.

(6) The number of *professors and instructors* at the Universities and colleges included in the list of the U.S. Commissioner of Education is 17,000. The number of *day students* in our Universities and University Colleges is only about 20,500, so that there are almost as many University *teachers* in the United States as there are University *students* in the United Kingdom!

A careful study of the tables here brought together will do more than anything else to explain the success which has attended American manufactures and commerce in recent years. America has learnt that to energy and enterprise must be added trained intellect and a familiarity with recent advances in

science. Other things being equal, that nation will be most successful in the competition for the markets of the world which makes the most generous provision for the higher education of its people.

(3)

THE REQUIREMENTS OF THE UNIVERSITY OF BIRMINGHAM.¹

Among the many documents prepared by Principal Sir Oliver Lodge in relation to the development of the University of Birmingham, there are more than one of which the interest is by no means merely local. Of these, the pamphlet entitled "Survey of the Sciences," which forms an appendix to a paper on University Development, is of especial importance at the present time, for we are glad to know that the belief that the weakness of our Universities must lead to national weakness in several directions is growing with a rapidly accelerating pace.

It may be long in this slow-moving country before the influence of brain-power on history is recognised as fully as the influence of sea-power has been, thanks to Captain Mahan, but undoubtedly it will be bad for our future if much more time is lost.

The paper on the "Survey of the Sciences" begins as follows :—

"In a recent pamphlet I considered the question of the relation of the University of Birmingham to its central and suburban sites, with a view of determining what recommendations should be made to the Council concerning the Departments which ought to migrate and the Departments which ought to remain. I was able to arrive at some judgment on the matter except in connection with the Faculty of Science, and there the problem became so complicated that it was necessary to make a survey of the sciences in order to get the material on which to form an opinion. This survey is now printed, not only as an appendix to the former paper, but because it is hoped that it may be useful for other purposes ; especially I hope that it may be of interest to those who are able to help financially in the forthcoming great educational development of the future, enabling

¹ *Nature*, January 1, 1903.

them to realise the immensity of the area which we attempt to cover, and the largeness of the sum which could be properly invested in suitable buildings and equipment and in endowment of staff. Our position is such that if some man of power thought fit to exercise it by entrusting us with a sum of five millions for University development, it could be well and properly employed; nor could such an investment fail to exercise an extraordinary influence on the progress of the country. Hitherto the ideas of this country in education and scientific research have been conceived on a wholly inadequate scale, and without proper appreciation of the vast extent of territory over which a modern University is called upon to preside."

After referring to the sciences already dealt with at Birmingham and the collateral branches and practical applications, the pamphlet concludes as follows:—

"In venturing to name such a sum as five millions, I have had in view certain considerations which it may be well to set forth.

"First it has been found that the Carnegie donation to Scottish Universities is insufficient to attain its objects, and already it appears likely that it may have to be doubled.

"Next it is well known, and indeed painfully familiar to all who have to do with administration, that every new department started, and every new building erected, means an increase of current expenditure and a drain upon resources. Expenditure is called for on behalf of rates, portering and cleaning, heating and lighting, maintenance, depreciation and supersession of equipment, and materials for experiments and processes. There are also annual grants to be made to the Library, to the various Laboratories and Museums, and to departmental Libraries. Then there is a large disbursement for salaries of demonstrators and curators and assistance and technical instructors. All these expenses come out of revenue, and are probably best provided for by the income derived from fees, and from the contemporary support of County and other bodies so as to preserve dependence on the interest of the living generation. But it is highly desirable to keep fees low—not by any means to abolish them, but to keep them low—so as to bring higher education within reach of all who are able to make use of it: a number which, with the improvement of schools, will probably be rapidly increasing.

Hence it is probable that the above-mentioned items of annual expenditure will absorb the whole of the ordinary annual income and leave nothing for the payment of the chief Professors and Lecturers. Everywhere it has been found essential that chairs shall be endowed, so as to put them on a permanent and substantial basis ; moreover, it is vitally important to be able to attract the best men, wherever they are to be found. At the present time it is not usually possible to compete with other places for the best men unless we can offer a sum comparable to 1000*l.* a year, and in some subjects more.

“An invested million will therefore on the average relieve the annual income of the stipends for 30 principal chairs. There must be a large number of Lectureships, or subsidiary and supplemental chairs, and 60 of these at 500*l.* each could be provided with the second million.

“The buildings already in progress on the new site are to cost more than a quarter of a million, and the remainder of what has been sketched out and actually contemplated will cost the other three-quarters. Another half million at least will be needed to equip them properly.

“The older or central site will also need considerable enlargement, and fresh buildings should rise there. Half a million may be set aside for ultimate building and equipment on and near the Mason College site.

“Four out of the five millions are thus accounted for ; the fifth is intended for a real attempt at scientific research in all departments. A fund by which men could be sent to any part of the world : to study tropical diseases, or fisheries, or mining possibilities—to investigate either nascent industries or injured industries of any kind ; a fund which could equip research laboratories at home, and could defray the expense of researches undertaken on a large or engineering scale, so as to bring in rapidly some practical results. At present there are men who perceive how many things could be reformed or improved, whether in purification of the atmosphere, or in novel modes of locomotion, or in many other ways ; but they lack the means to demonstrate their plans or to try experiments. Manufacturers and Municipalities sometimes try experiment on a very extensive scale indeed—a really commercial scale—and in case of failure the resulting experience is over-dear. The endowment would not allow experiments on such a scale as that ; considering the variety of subject, the amount available

for each would permit of no extravagance. Some of the experiments undertaken would undoubtedly fail, yet the success of a few would far more than compensate for the failure of many, and the activity could not but conduce to progress.

“The fund would have to provide not only the necessary appliances and assistance, but it would endow fellowships for post-graduate study, and would attract workers from many parts of the world, and certainly from the Colonies.

“One Principal could not possibly supervise all the multifarious activities which we have thus supposed may some day be called into being. There would have to be a Research Principal (whatever he might be called), to organise and superintend the scientific and post-graduate study; a Technical Director, in touch with all the technical departments; and an Educational or General Head, to supervise the general scheme of the College in all its various avenues to a degree, and to take a lead in whatever conduced to general culture.

“If the scheme is lavish it represents lavishness in the right place. It is the kind of lavishness for which the nation is waiting—one of the few kinds of which hitherto it has been afraid.

“ ‘There is that scattereth but yet increaseth :
There is that withholdeth more than is meet, but
it tendeth to poverty.’

“These lines refer not to individual wealth alone, but to National wealth also. We have failed to make the most hitherto of the brains and energy of our more able and specially-gifted youth, but have cramped them by the necessity of earning a living : a process wholesome enough for the individual, and right for 999 out of every thousand, but for the remaining one far less repaying to the Commonwealth than the special service which he could render, if set free and encouraged by suitable surroundings for a few years of research, following on a thorough educational preparation. Not all of these would justify their selection : nine-tenths of them even might do only moderately well ; but the discoveries of the select tenth would be of incalculable value. The world has been wasteful of its genius hitherto. It thinks too facilely that people exceptionally endowed will struggle to the front somehow. A few do, but a number do not ; the conditions are not favourable ; and the struggle for existence, though doubtless a stimulating

training for the hardier and sturdy virtues, is not the right atmosphere for the delicate plant called genius. Different kinds of treatment are suited to different characters, and the hot-house plant will not thrive in bracing arctic air.

"From the Trust Deed with which Mr. Carnegie has endowed a research Institution at Washington with ten million dollars, I extract the following altogether admirable statement of '*aims*':—

"1.—To promote original research : paying great attention thereto, as one of the most important of all departments.

"2.—To discover the exceptional man in every department of study, whenever and wherever found, inside or outside of schools ; and to enable him to make the work for which he seems specially designed his life-work.

"6.—To ensure the prompt publication and distribution of the results of scientific investigation ; a field considered highly important.

... "The chief purpose of the founder being to secure if possible for the United States of America leadership in the domain of discovery, and the utilisation of new forces for the benefit of man."

(4)

THE REQUIREMENTS OF THE WELSH UNIVERSITY AND COLLEGES.¹

We saw that the great bulk of the endowments of the German Universities was provided by the State, 81 per cent. of the total being so provided in Prussia, and 74 per cent. in Germany as a whole. Wales, happily or unhappily, possesses comparatively few men whose individual possessions could enable them to take part in endowing her colleges in any way commensurate with the need. Of the sums that have been raised for buildings, a great part has been collected, at the cost of healthy but disproportionate effort, from the shillings and pence of artisans and small farmers or traders. It is not surprising, therefore, to find that the colleges and the University depend already mainly upon public funds. The County Council grants to Cardiff and Aberystwyth must in

¹ *Nature*, July 16, 1903.

fairness be counted as fees, not endowments, since they are given in return for teaching a definite class of students, and a change of policy in the local authorities might at any time modify or even divert their contributions. The figures are approximately¹ as follows, reckoning the interest on investments, as heretofore, at $2\frac{1}{2}$ per cent., and including in the Government grants those devoted to special objects, such as agriculture, and the training of primary teachers.

Present Endowment of University Education in Wales.

					Income from Private Endowments.	Income from Government Grants.
					£	£
University College, Aberystwyth	...	...	...	...	375	6000
University College, Bangor	...	...	...	...	1225	6000
University College, Cardiff	...	...	...	...	750 ²	5250
The University of Wales	...	...	...	...	—	4000
Totals					£2350	£21,250
Percentages					10	90

There is only one conclusion. In great cities like Liverpool and Manchester there is accumulated wealth and an accumulated tradition of culture to which their colleges have appealed with some success. In Wales the culture has been for centuries remote from University life, and the wealth, as we have seen, is non-existent. If, therefore, the Government wishes that the 21,000*l.* a year which it now spends in grants to the colleges and the University of Wales shall not be wasted, it is high time that it should face the question of what they really need.

In order to represent these needs in as concrete a form as possible, we have made inquiries as to the sums which, in the opinion of responsible persons at each college, would suffice to place them in a position to discharge their work with real efficiency. In each case we shall mention two capital sums, the one that required to construct or complete the buildings and equipment of the college, the other that required as an endowment for maintenance, the interest in this latter case being reckoned at $2\frac{1}{2}$ per cent. Aberystwyth has from the

¹ The exact figures vary slightly from year to year.

² Including the annual grant of 350*l.* from the Drapers' Company for engineering.

first been the most fortunate of the three colleges in the matter of buildings, so that its needs under this head are smaller; similarly Bangor needs slightly less towards maintenance as being possessed of somewhat larger invested endowments, Cardiff and Aberystwyth having only very small possessions of this kind; trust-funds for scholarships are, of course, disregarded altogether in the estimate.

The figures assume that the present Government grants will continue, and under both heads state the sums needed in addition to all the resources the colleges at present possess.

Funds needed for University Education in Wales.

	A. For Buildings and equipment.	B. For Endowment.
	£	£
University College, Aberystwyth	99,800	1,071,500
University College, Bangor	176,500	960,400
University College, Cardiff	162,000	1,176,400
The University of Wales	—	288,400
Totals	£438,300	£3,496,700
Grand total	£3,935,000	

In round figures, therefore, we may say that University education in Wales needs an endowment of four millions sterling to secure its efficiency. This will not be thought an extravagant figure when it is remembered that the need of the Birmingham University was estimated at five millions, and that the Welsh colleges minister to the needs of a far more diverse population. The agriculture, the manufactures, the mining and the over-sea commerce of Wales all demand the enlightenment and intelligence which can only be developed in Universities efficiently equipped for their work.



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